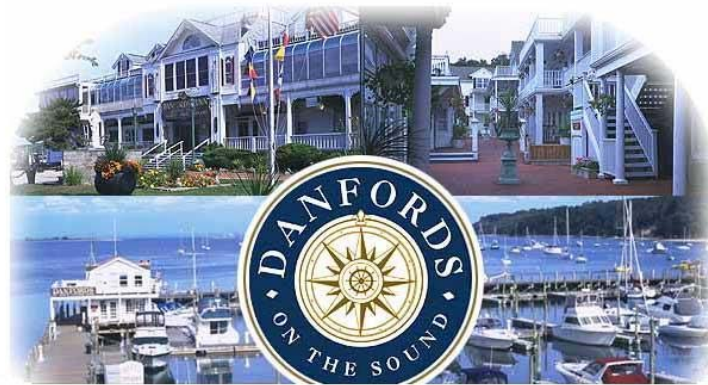


# RHIC Run-7 Au-Au Operation

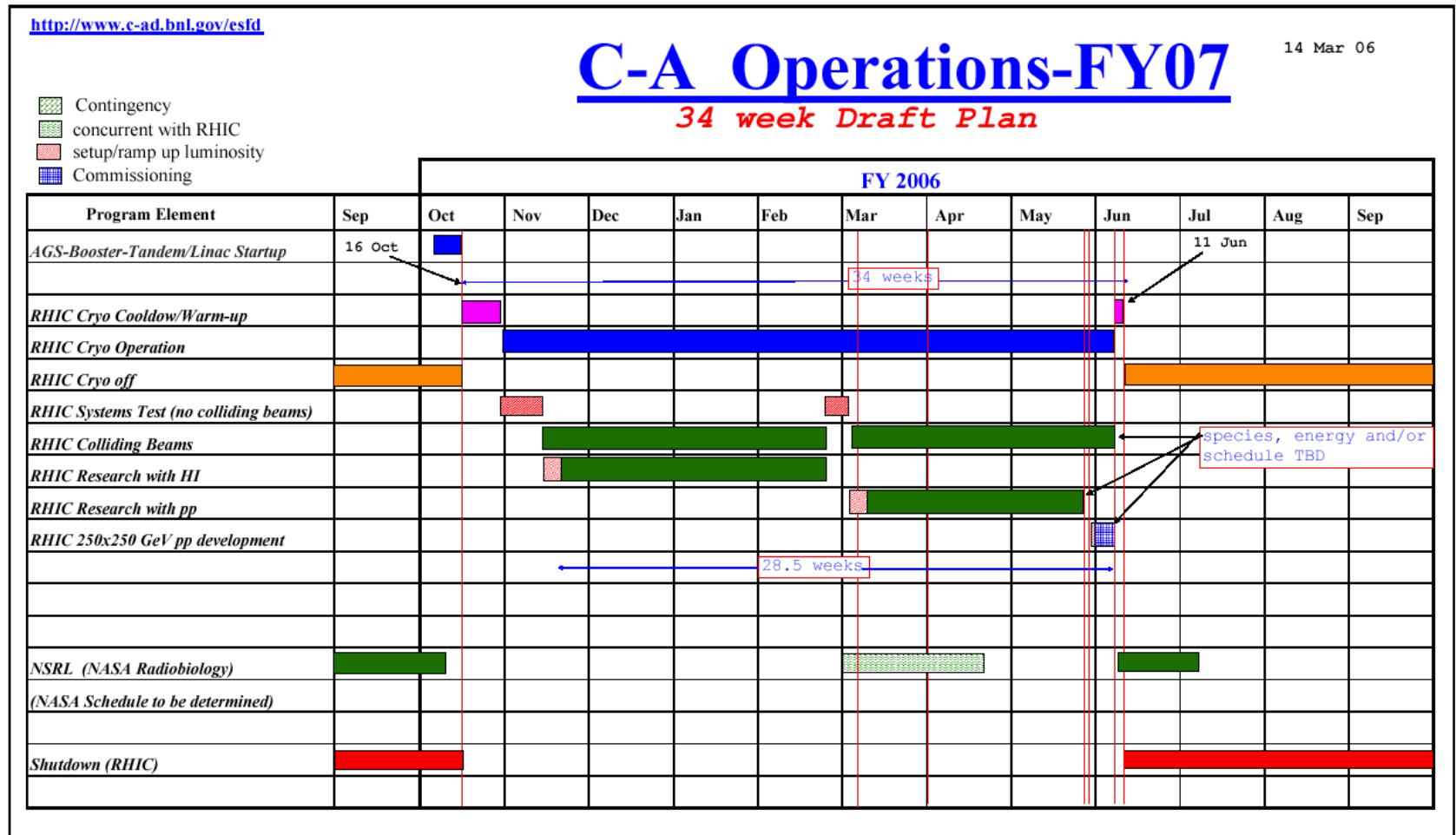
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## **RHIC Retreat 2006**

RHIC Retreat, Port Jefferson  
10 July, 2006

# Run 7 Draft Schedule



- RHIC cold beginning of November
- assume 34 cryo-weeks
- assume two mode running: HI + other (d-Au, pp, ...)
- HI could include low energy run

# RHIC Run organization

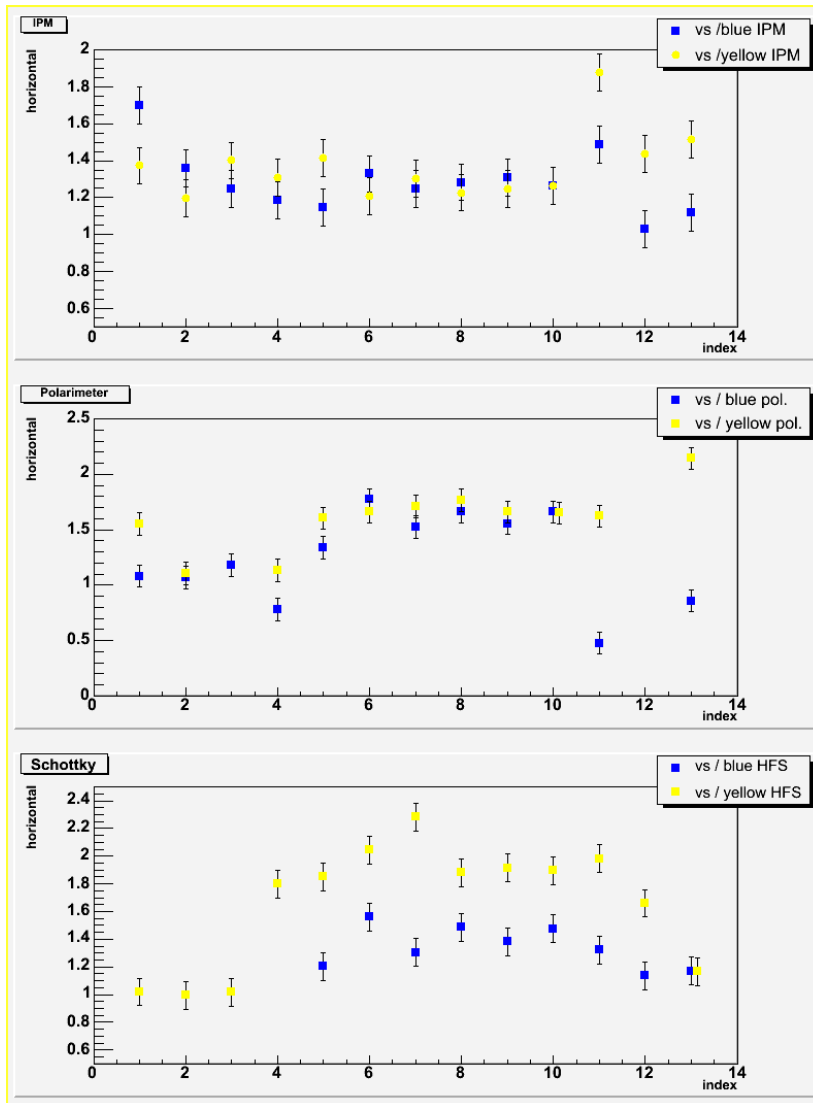
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- Run Coordinator HI Angelika Drees
- Run Coordinator PP/other Christoph Montag
- Scheduling physicist Kip Gardner
- RHIC shift leaders: Bai, (Drees), Luo, (Montag), Ptitsyn, Kewisch, Zhang, Beebee-Wang, McKay
- Back-up RHIC shift leaders: Fischer, Montag/Drees, Trbojevic, Pilat, Satogata
- Operations + RHIC specialist (Marr)→ larger role during set-up, ramp-up, beam-ex
- same 'old question': should operations be involved more and AP less? (yes) Was the role of operations improved last run? (yes) Did we do better? (not really) Were we more efficient? (reached plateau)

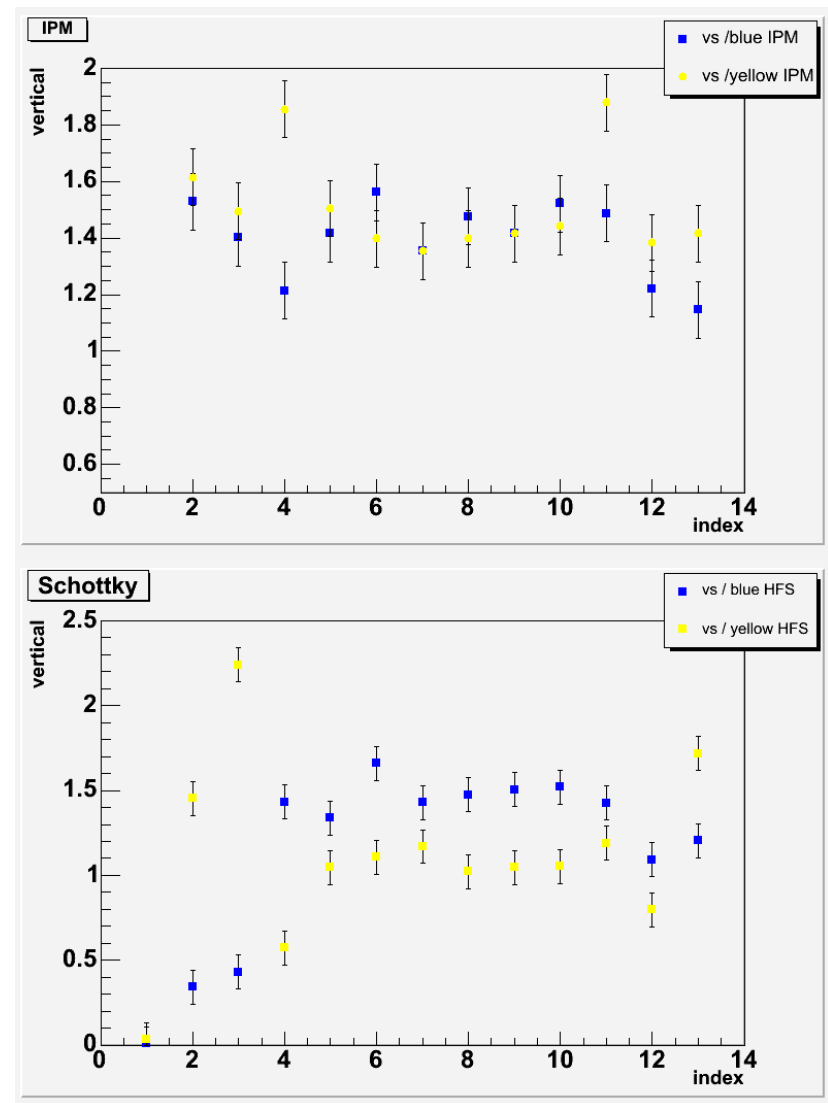
## Weekly schedule:

Monday	Scheduling meeting
Monday	RHIC Weekly meeting
Tuesday	Time Meeting & Machine-experiments meeting
	operations analysis meeting (new)
?	Beam Experiments
?	maintenance day (every 3 weeks)
daily/varying	RHIC run meeting
	(will have to change time slightly: 9:00 am?)

# Operations Analysis Example: compare Vernier Scans with IPM, Schottky, Polarimeter



Horizontal



Vertical

# RHIC Run-4 - Au-Au operation

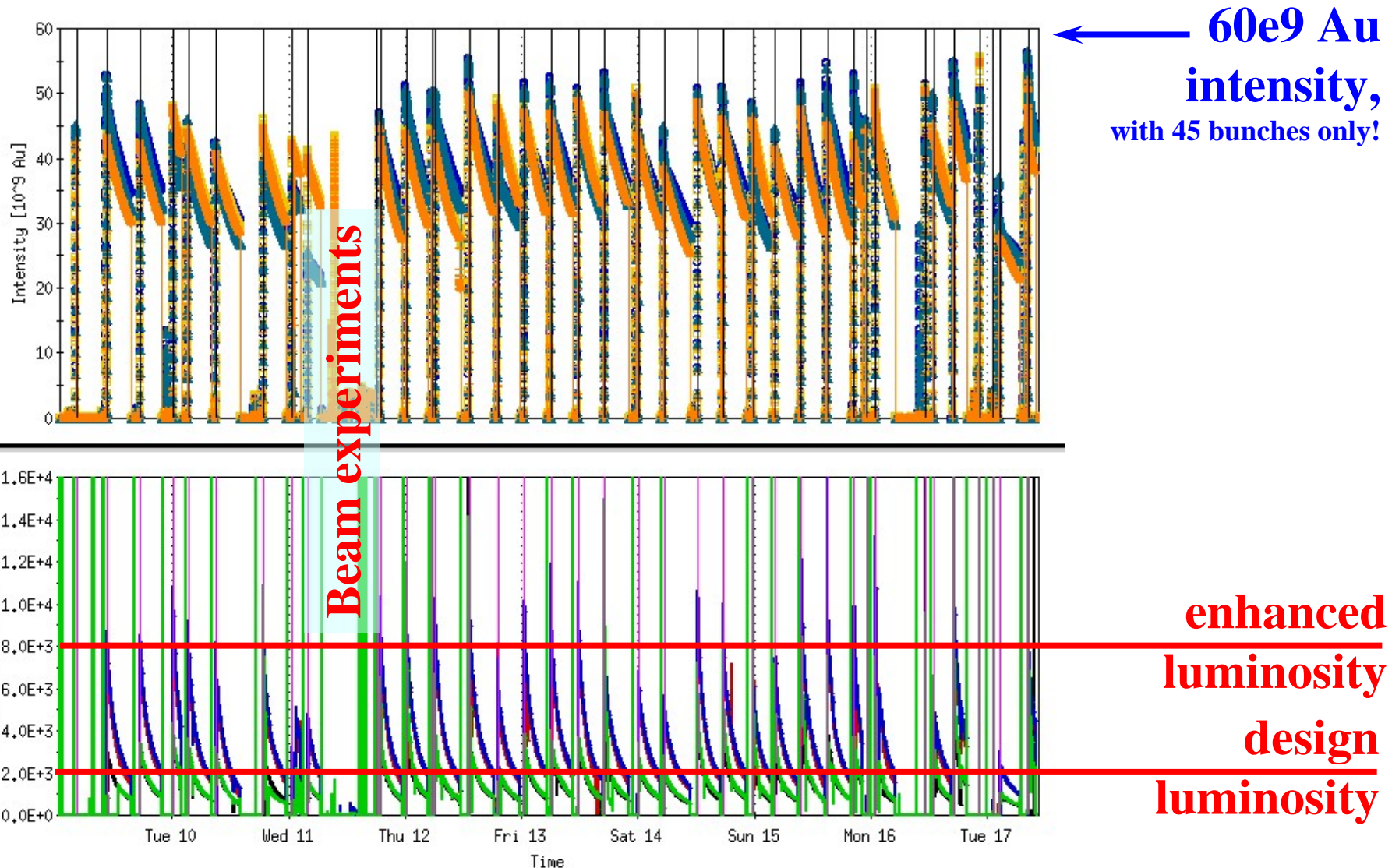
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## Major achievements Au-Au: from W.Fischer, Retreat 04

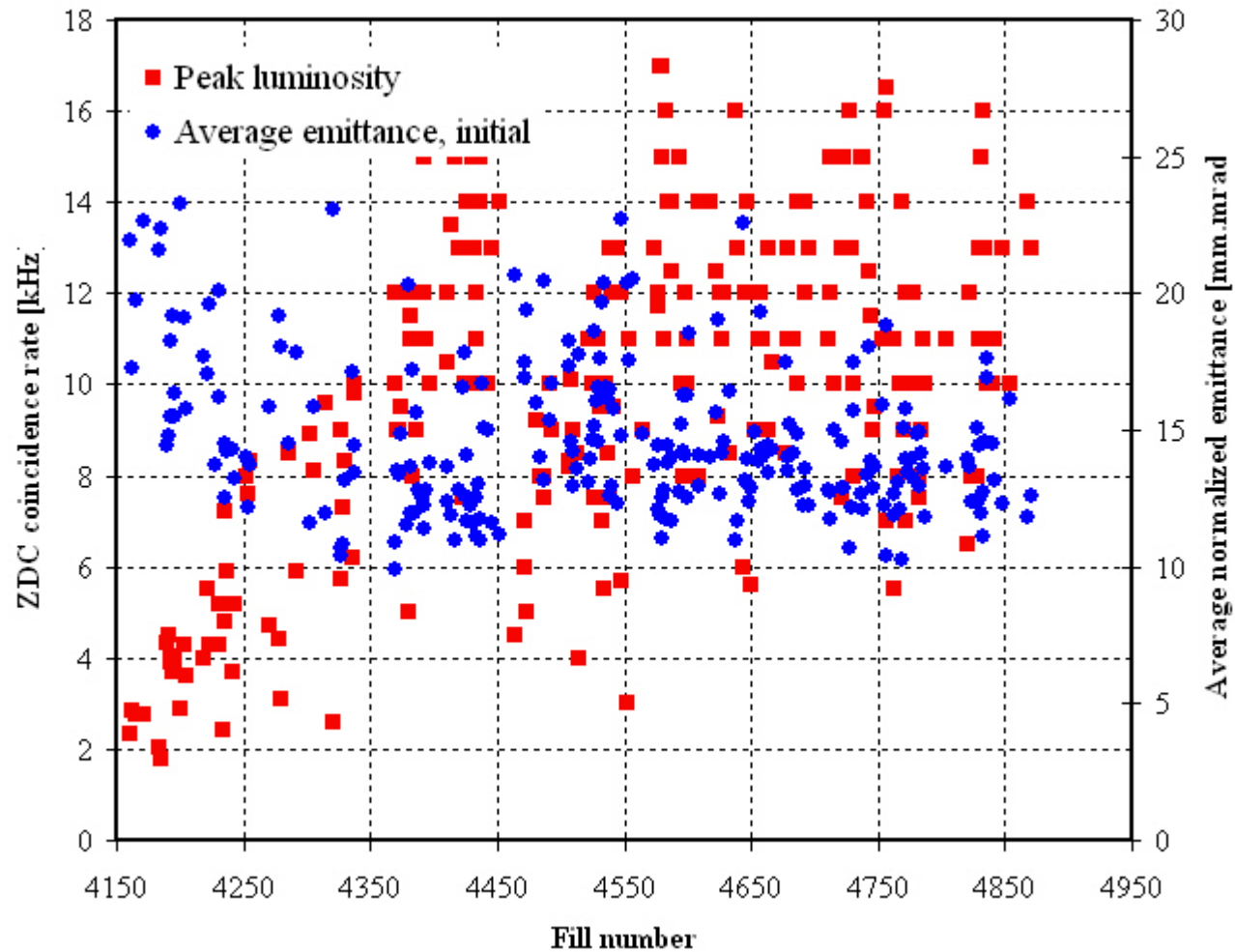
- Start-up/ramp-up in 4 weeks (1 week less than planned)
- Consistent high bunch intensity from injector ( $\geq 10^9$  Au)
- Time in store increased to 53% (65% at 31.2 GeV/u)
  - not yet exceeded!
- Reliable, almost complete rebucketing into storage rf
- Steering and collimator setting time reduced to 10 min
- Best 7 days delivered  $179 \mu\text{b}^{-1}$  to Phenix (2x Run-2)
- Set-up for 31.2 GeV/u run in less than 2 days

# RHIC Run-4 record week

Week 9 Feb to 17 Feb [66% of calendar time in store]=> so we've done it before ;)



# Run4 Emittances and Luminosities (Initial)

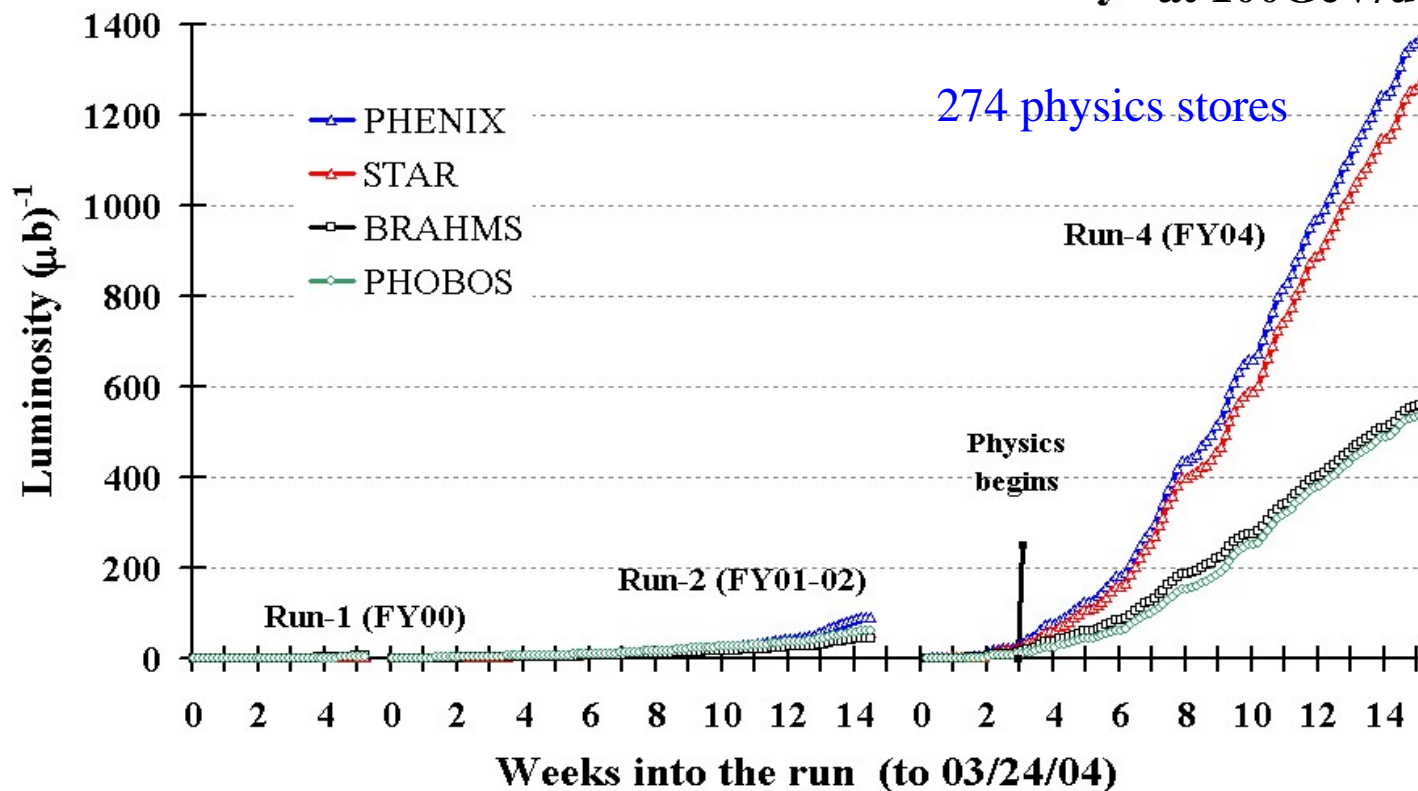




# Achieved: RHIC Run-4 - Au-Au luminosity evolution

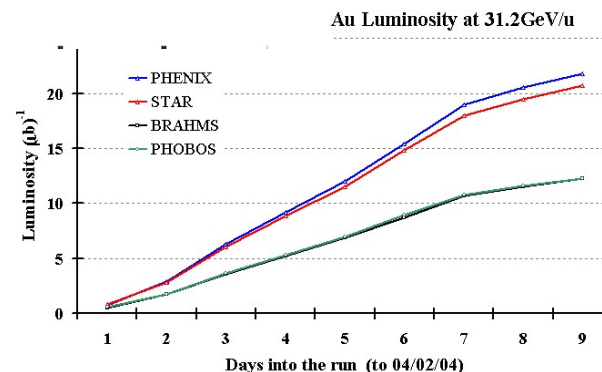
f. W. Fischer, retreat 04

## RHIC Delivered Au-Au Luminosity at 100GeV/u



*hard to top!*

	100GeV/u ( $\mu\text{b})^{-1}$	Relative to Run-2	31.2GeV/u ( $\mu\text{b})^{-1}$	Relative to Run-4
PHENIX	1370	15x	21.8	2x ?
STAR	1270	21x	20.7	2x ?



-> can we improve on this?



# Machine Set-up and Ramp-up

---

- set-up w. beam during cool-down (2 weeks)
  - injection into one ring as soon as temperatures allow circulation beam
    - evening and owl-shifts once one ring is ready ( $\Rightarrow$  daily meetings begin)
    - AGS-RHIC synchro ...
- start-up mode (2 weeks, depends on challenges, can be improved )
  - 3 shifts/day, daily meetings
  - injection development
  - ramp development (low intensity)
  - store development (low intensity, 1<sup>st</sup> collisions, coll. set-up, ...)
- ramp-up mode (1 week)
  - 1-2 shifts per day, collisions over night, daily meetings
  - increase intensity
  - collimation, collision optimization
- physics (? weeks)
  - increase number of bunches
    - occasional beam development during the days, reduced meetings

# Run-7 upgrades/improvements

For FY2006	For FY2007	For FY2008
	<b>RHIC injectors</b>	
LINAC cooling tower	AGS MMPS transformer AGS ion pump controllers Booster/AGS bunch merge => Brennan, Gardner	AGS low level rf upgrade
	<b>RHIC luminosity, polarization and background</b>	
Shielding STAR Stochastic cooling test NEG pipes (150 m) CNI polarimeter vacuum and targets 10 Hz IR orbit feedback Vacuum pumps in arcs Complete vertical alignment	Sector 3 triplet 24h movement Stochastic cooling NEG pipes (100 m) CNI polarimeter upgrade Rf storage windows Nonlinear chromaticity correction	Low level rf upgrade Transverse damper
		yellow only => Blaskiewicz talk
	<b>RHIC time in store</b>	
QLI reduction BPM system upgrade Orbit correction Injection set-up IR PS reliability Gradient error correction Decoupling on ramp Beginning-of-store automation	QLI reduction BPM system upgrade Orbit correction Injection set-up Service building environment Gradient error correction	Service building environment
		work in progress

# Run-7: ramp, set-up and efficiency

---

## ■ More automation:

- Steering → small changes compared to run4
- Collimation (small SW changes compared to run4)
- Ramp & store orbit correction → improved  
(time saving: machine became reproducible over whole run, can eliminate luminosity optimization, also saves time when exp. magnet configuration is changed)
- **Gap Cleaning**: continuous during the store (no change), good up to  $1.4 \cdot 10^9$  ions/bunch
- Automate/Sequence all of the above

## ■ ongoing operations analysis meetings throughout the run

## ■ Configuration database

## ■ Instrumentation: BBQ, tune feedback, BTFs, de-coupling on the ramp

# Expected Luminosity for HI

Fiscal year		2002A	2004A	2006E	2007E	2008E
No of bunches	...	55	45	78	90	111
Ions/bunch, initial	$10^9$	0.6	1.1	1.1	1.1	1.1
Average beam current/ring	mA	33	49	85	98	121
$\beta^*$	m	1	1	0.9	0.9	0.9
Peak luminosity	$10^{26} \text{ cm}^{-2} \text{ s}^{-1}$	5	15	28	32	40
Average store luminosity	$10^{26} \text{ cm}^{-2} \text{ s}^{-1}$	1.5	4.0	7.0	8.1	9.9
Time in store	%	25	53	56	58	60
Maximum luminosity/week	$\mu\text{b}^{-1}$	25	160	236	282	360
Minimum luminosity/week	$\mu\text{b}^{-1}$			160	160	160
Maximum integrated luminosity	$\mu\text{b}^{-1}$	89	1370	2480	2970	3780
Minimum integrated luminosity	$\mu\text{b}^{-1}$			1680	1680	1680

- **No. of bunches:** likely to increase gradually during the run, maybe up to 111
- **ions/bunch:**  $1.1 \cdot 10^9$  achieved => do we need booster bunch merge to increase this?  
Weeks of development time in booster and AGS necessary before RHIC starts.  
(=> talk M. Brennan)
  - transition crossing => talk C. Montag
  - vacuum/pressure rise => talk D. Hseuh
- **$\beta^*$ :** squeeze to smaller values than 1.1? (=> background, collimators ...)
- **time in store:** how can we reach 60%? Automation, QLI reduction, PS reliability, weather ...
- **bunched intensity, vertex:** IBS suppression lattice & stochastic cooling
  - IBS suppression: 2-3 days development time: need to decide soon if we want to try (=> talk of V. Litvinenko)
  - stochastic cooling: yellow only (blue in testing), will not yet reduce vertex distribution significantly but increase yellow bunched lifetime, 10% L increase?

# Run 7 Strategies

## ■ As much routine as possible (QGP factory)

- avoid major and costly changes/upgrades:
  - no booster bunch merge
  - avoid risk of man-power shortage (cooling)
  - no IBS suppression lattice
- only small changes at the time
  - stochastic cooling (we will have anyway)
  - some improvement on  $\beta^*$  (0.8 m?)
    - backgrounds?
  - slowly increase no. of bunches (limit < 111?)
  - automation (software), reduce time between stores
  - reduced set-up time due to tune-feedback and decoupling on the ramp
  - touch machine as little as possible
  - go into production mode as early as possible
  - focus on reliability

## ■ as aggressive as possible

- get major upgrades out of the way:
  - booster bunch merge (requires HW changes and development time > 2 weeks)
  - develop alternative to debunch-rebunch in the AGS (untested!)
    - gap cleaning?
    - polarization development?
    - emittance?
    - transition crossing/pressure
  - focus on intensity (vs. cooling)
- develop IBS suppression lattice
  - start-up with a ramp that's still undeveloped
  - unknown outcome (lost time if doesn't work)
- production mode will start later, time between stores could be longer
  - machine might be 'touchier' (unknown lattice) => more lost ramps, less reliability
  - cooling (low mom. spread) could cause yellow to be more delicate => chromaticity control in yellow more important (also applies to routine strategy)

## ■ lattice and working point: tbd (IBS suppression?, beta-squeeze?)

- IBS suppression lattice has the potential of increasing luminosity by ~25%  
(=> Vladimir's talk)
- lattice will have  $\beta^* = 0.85, 0.85, 5, 5, 5, 5$  (IBSsup or not)

## ■ Start of physics running

mutual interest in early start of regular stores/operations

guidelines for start of physics: adequate collisions, rebucketing, collimation in place

mutual decision to define physics start-up

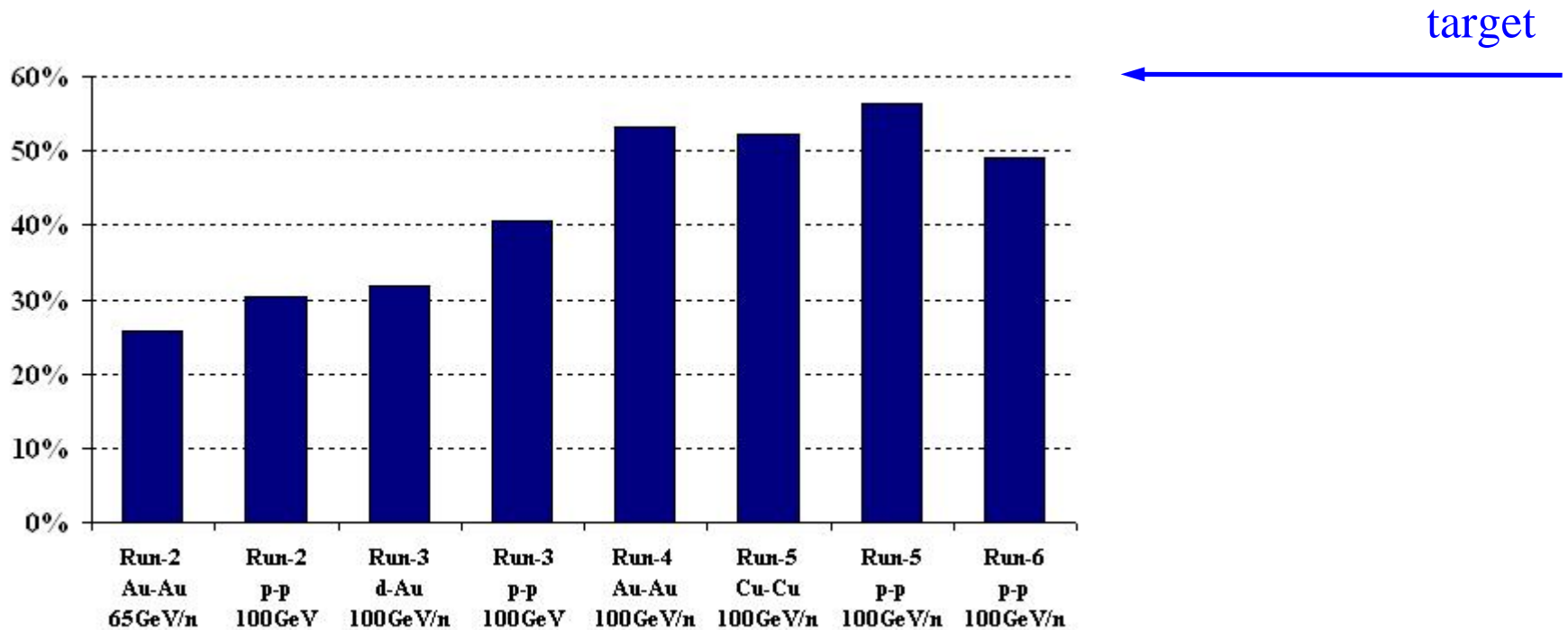
## ■ Development: day shifts, 8am-4pm, after agreement or approval by experiments/scheduling physicist

## ■ Beam experiments: 12 hours/week (s. Kevin's comments)

## ■ accesses: 3 week maintenance schedule preferred, 'cluster' with beam experiments, any other access: scheduling physicist (accumulate access requests, review ...)

## ■ End of store procedure - fixed length stores - end of store determined by MCR→countdown for experiments (automated in BERT?), length determined by luminosity lifetime and refill time.

# RHIC time in store



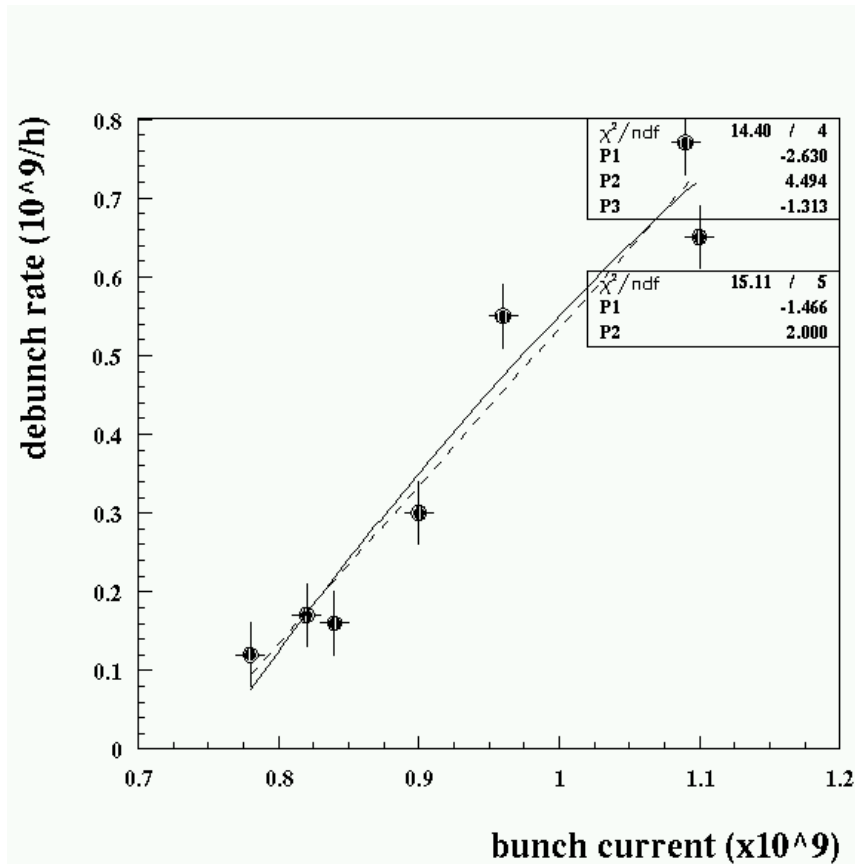
task force challenge: reach 60% of calendar time in store!

(s. W.Fischer's talk this morning)

=> too many new concepts tend to spoil time in store

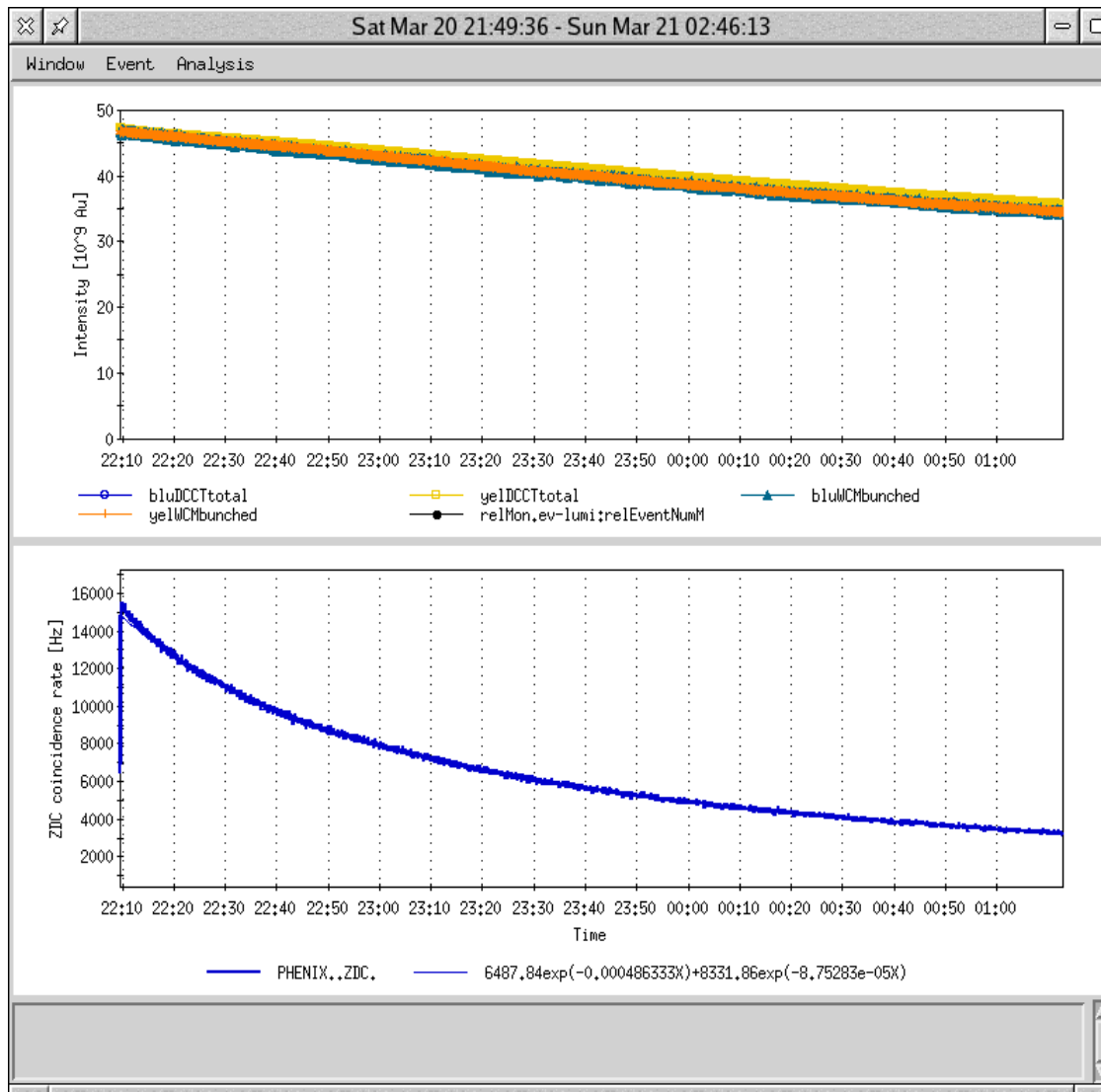


# Reminder: Gap Cleaning Efficiency



- existing data cannot determine 1<sup>st</sup> or 2<sup>nd</sup> order
- extrapolation allows  $1.4 \times 10^9$  ions/bunch with current gap cleaner and debunching rate
  - no IBS suppression assumed
  - no cooling
- assume a store length of 4 hours before limit of debunched beam is reached
- improve gap cleaner?
- IBS suppression lattice would help both rings, cooling only yellow
- $1.4 \times 10^9$  ions/bunch can only be reached if injectors are changed

# Luminosity Lifetime



need 2 exponentials  
to fit luminosity lifetime

two components:  
fast:  $\sim 0.5$  h  
slow:  $\sim 2$  h

improvements (cooling,  
higher intensity, IBS  
suppression,  $\beta^*$ ) will  
affect slow component  
more due to collimation,  
steering and exp. turn-on

- It basically comes down to the question to decide
  - "QGP factory" or aggressive approach
  - do a mix of both
- There is up to x2 increase possible already just from
  - beta squeeze
  - yellow cooling (chromaticity control more important!)
  - number of bunches increase 45=>? (vacuum upgrade)
  - start-up and ramp-up is more routine, new RampEditor, better model ...
  - reliability improvements, improved instrumentation (coupling on the ramp)
  - improved time at store (automation, reduce time between store ...)
- Additional improvement can come from:
  - bunch intensity (booster bunch merge)
    - unknown limits: transition, gap cleaning, instabilities, vacuum ...
  - IBS suppression lattice
    - "new" machine, additional set-up time, unknown reliability, stability and reproducibility
- don't change too many parameters at once
  - this will apply to any future run
  - explore some of the limits now rather than later
- recommend: do IBS suppression lattice OR bunch intensity increase this run